Effects of COVID-19 lockdowns on fine particulate matter concentrations

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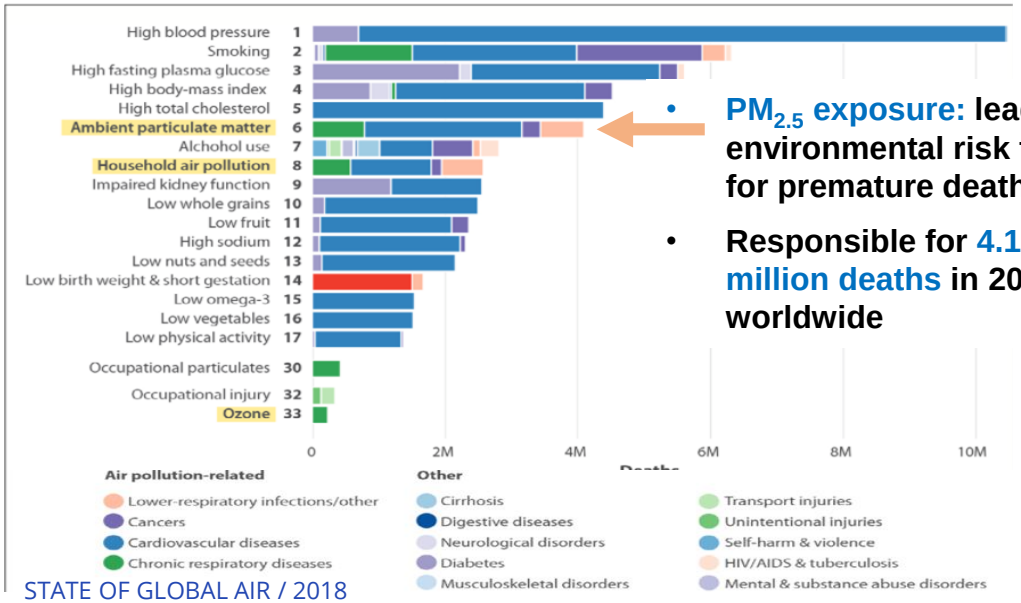
AC-VC Topical Seminar on “Covid-19 impact: what can be learnt from satellite observations and the emission changes?”

June 13, 2021

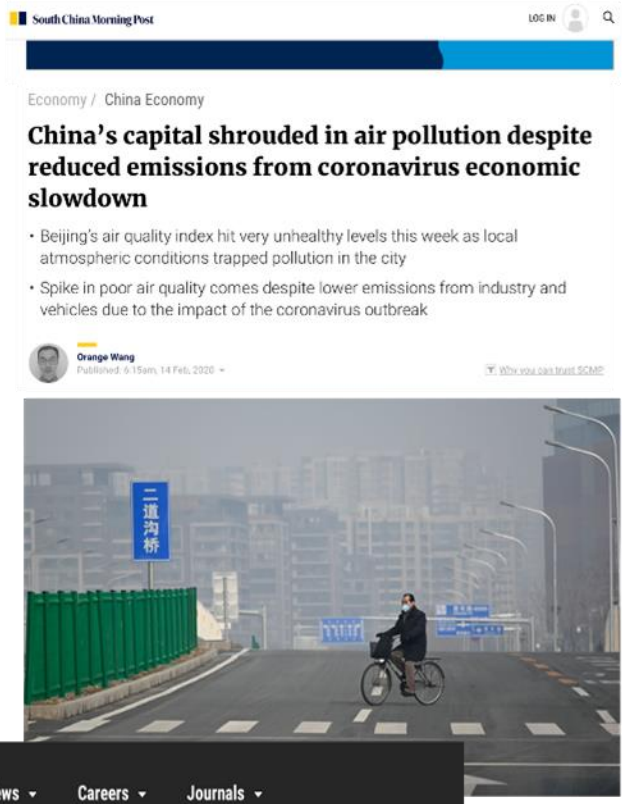
What was the impact of COVID-19 lockdowns on $PM_{2.5}$ concentrations?

Figure 1. Global ranking of risk factors by total number of deaths from all causes for all ages and both sexes in 2016.



STATE OF GLOBAL AIR / 2018

- **$PM_{2.5}$ exposure: leading environmental risk factor for premature death**
- **Responsible for 4.1 million deaths in 2016 worldwide**



> Environ Pollut. 2020 Jun;261:114465. doi: 10.1016/j.envpol.2020.114465. Epub 2020 Apr 4.

Can atmospheric pollution be considered a co-factor in extremely high level of SARS-CoV-2 lethality in Northern Italy?

Edoardo Conticini [1], Bruno Frediani [1], Dario Caro [2]

RESEARCH ARTICLE | CORONAVIRUS

Air pollution and COVID-19 mortality in the United States: Strengths and limitations of an ecological regression analysis

X. Wu[1,*], R. C. Nethery[1,*], M. B. Sabath[1], D. Braun[1,2] and F. Dominici[1,†]

Obtaining Monthly Regional Surface $PM_{2.5}$ Estimates

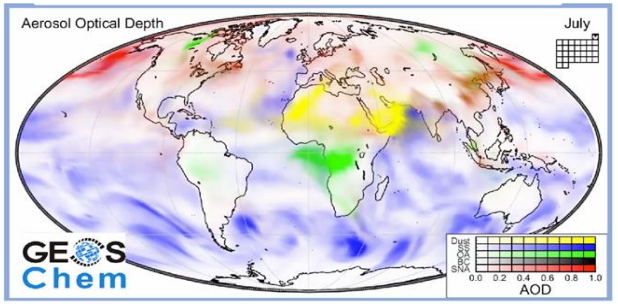
Satellite AOD **Spatial Resolution: 1 km to 10 km**

MODIS Deep Blue
MODIS Dark Target
MISR
MAIAC

AERONET: high accuracy AOD measurements

Spatial Resolution: Point Observation

Simulated atmospheric composition



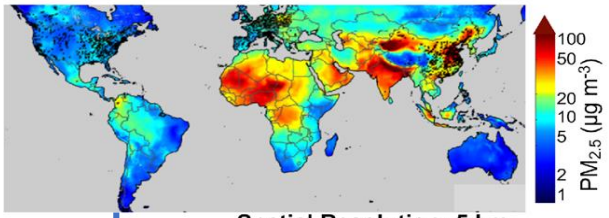
Spatial Resolution: ~50 to 200km

$$AOD_{SAT} \times \frac{PM_{2.5,SIM}}{AOD_{SIM}} = PM_{2.5}$$

van Donkelaar et al. 2010

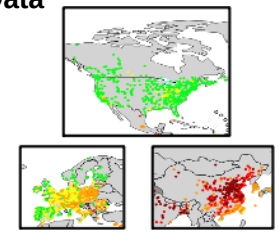
(function of: aerosol size, composition, diurnal variability, relative humidity, and vertical structure of aerosol extinction)

Geophysical $PM_{2.5}$ Estimates



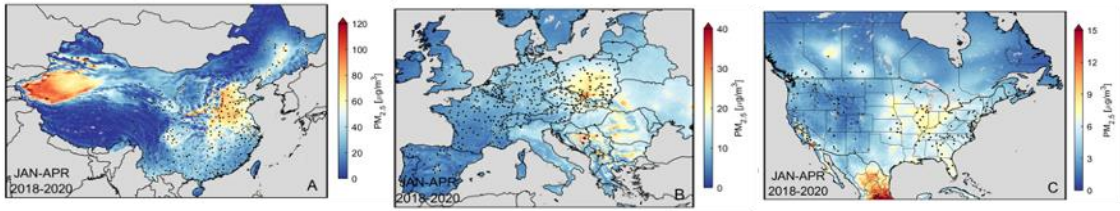
Spatial Resolution: 5 km

Monthly Regional Ground Monitor Data



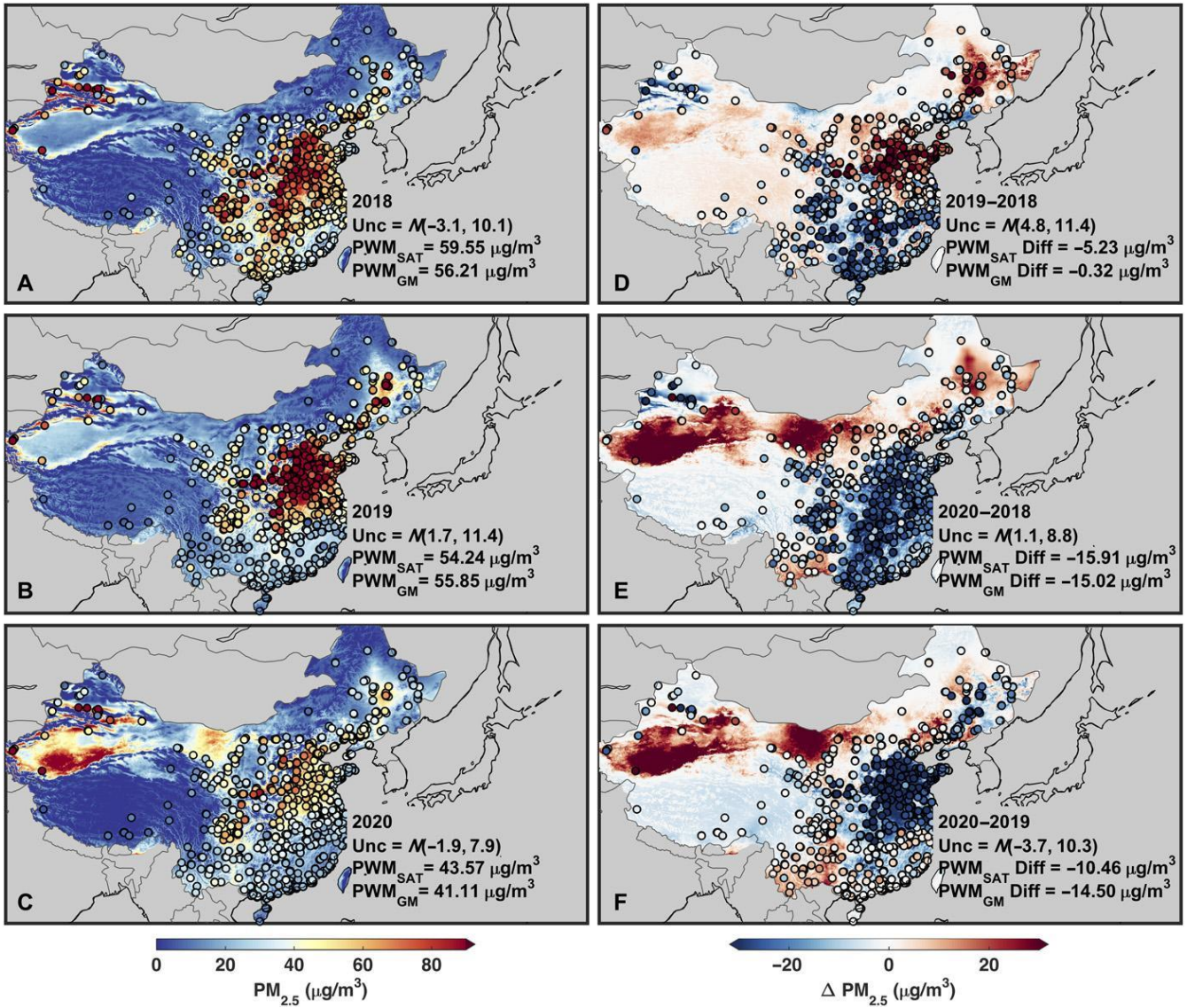
Statistical Fusion
(van Donkelaar et al. 2019)

Spatial resolution: 1 km **Monthly Regional Hybrid $PM_{2.5}$ Estimates**



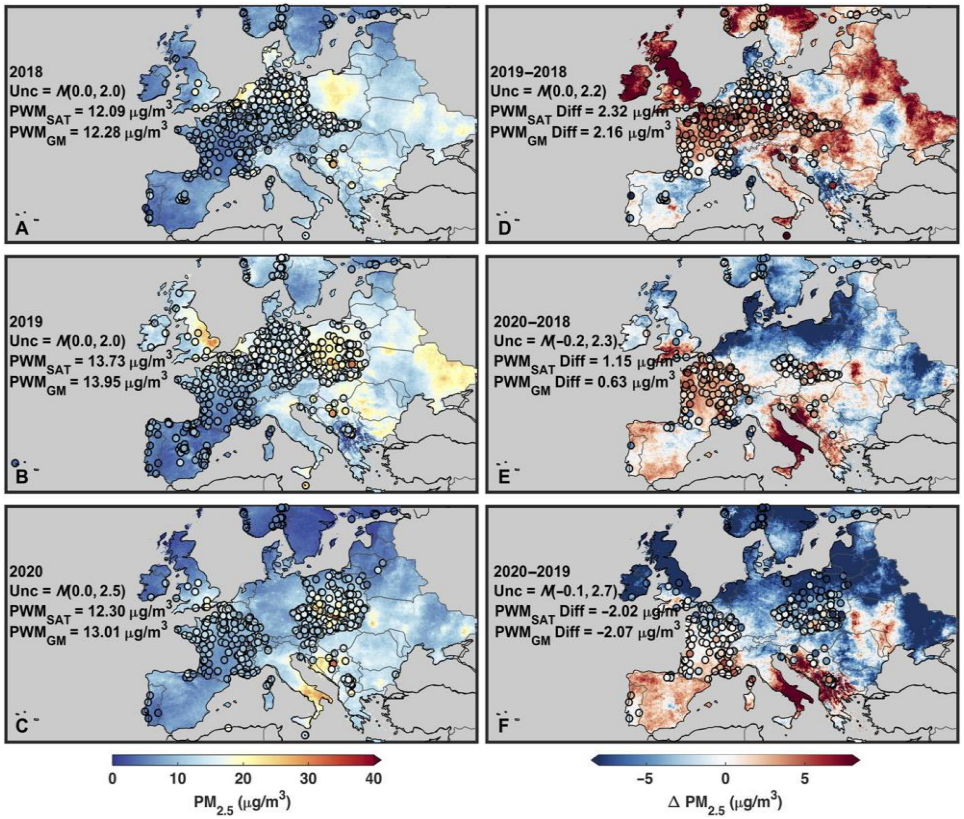
van Donkelaar et al., ES&T, 2019;
Hammer et al., ES&T, 2020;
Hammer et al., Sci Adv, 2021

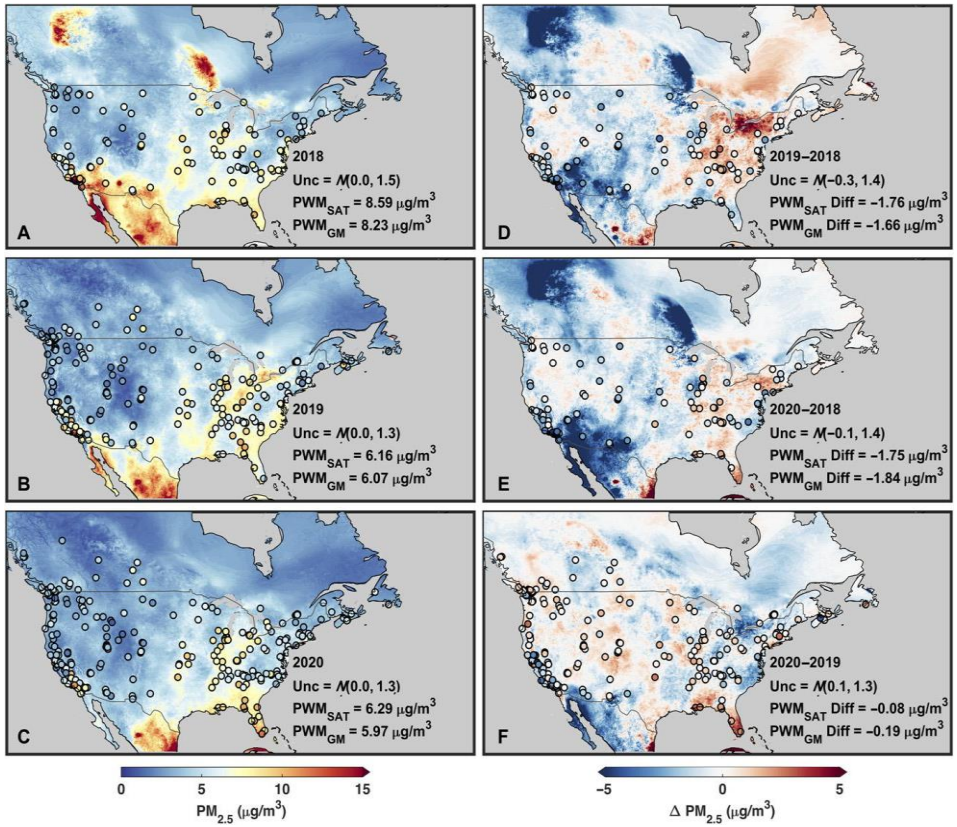
Monthly mean PM2.5 concentrations over China for February



Hammer et al., Sci Adv, 2021

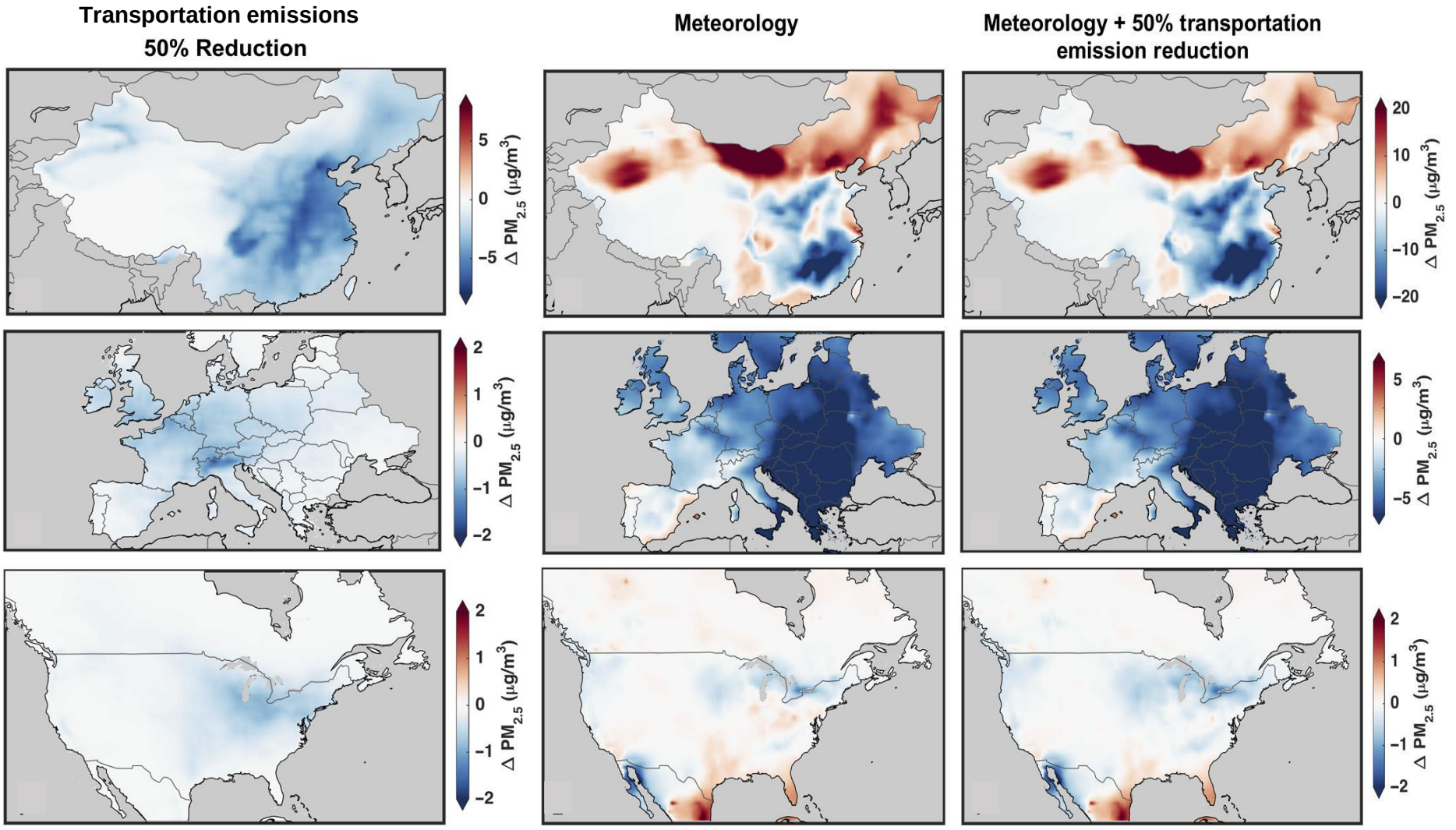
Monthly mean PM2.5 concentrations over Europe and North America for April





Hammer et al., Sci Adv, 2021

Change in simulated PM2.5 during the lockdown periods due to emissions and meteorology



Hammer et al., Sci Adv, 2021

Conclusions

- Derive monthly regional satellite-derived $PM_{2.5}$ estimates over China, Europe, and North America to examine the effects of COVID-19 lockdowns on $PM_{2.5}$ concentrations
- Evidence of a substantial decrease in $PM_{2.5}$ concentrations over the North China Plain region; combination of natural variability and emission reductions
- Complex relationship between $PM_{2.5}$ and emission sources
- Importance of natural variability on short term changes in $PM_{2.5}$

M. S. Hammer, A. van Donkelaar, R. V. Martin, E. E. McDuffie, A. Lyapustin, A. M. Sayer, N. C. Hsu, R. C. Levy, M. J. Garay, O. V. Kalashnikova, R. A. Kahn, Effects of COVID-19 lockdowns on fine particulate matter concentrations. *Sci. Adv.* **7**, eabg7670 (2021).

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